MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2022/2023 (TERM ID 2210)

EET3196 – ENERGY TECHNOLOGIES

(ME)

9 FEBRUARY 2023
2.30 p.m. - 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of only three printed pages, including this cover page.
2. Answer all questions.
3. Write all your answers in the answer booklet provided.

Question 1

a). Derive the formula of usable power P, in terms of α, ρ, r, and v, available in the wind, where α = an efficiency factor determined by the design of the turbine, ρ = mass density of air, r = radius of the wind turbine, and v = velocity of the air. Consider a cool 15°C (59°F) day at sea level, air density of 1.225 kg/m^3, an 8 m/s (28.8 km/h or 18 mi/h) breeze blowing through a 100-meter diameter rotor. Calculate the total power of the breeze through the 100-meter diameter rotor. [5 + 5marks]

b). One of the main problem of the tidal energy is that its production cycle will not always be in phase with the demand cycle. Explain. [5 marks]

c). Flowing water is directed on to the blades of a turbine runner, creating a force on the blades. Since the runner is spinning, the force acts through a distance (force acting through a distance is the definition of work). In this way, energy is transferred from the water flow to the turbine. Water turbines are divided into two groups; reaction turbines and impulse turbines. The precise shape of water turbine blades is a function of the supply pressure of water, and the type of impeller selected. What are reaction and impulse turbines? [5 + 5 marks]

Question 2

a). Calculate the power produced per m^2 of wind turbine disk area for a wind velocity of 20 miles per hour, assuming a power coefficient C_p of 0.5 and an air density of 1.2 kg/m^3. Calculate the diameter of a wind turbine that would supply a 1 MW of electrical power under these conditions. (1 mile = 1.609 km) [5 + 5 marks]

b). Solar energy can be stored at high temperatures using molten salts. Why are salts such an effective storage medium? [5 marks]

c). Describe the longevity issues of renewable energies. [5 + 5 marks]

Continued . . .

Question 3

a). Lithium hydride, LiH, has been proposed as a possible nuclear fuel. The nuclei to be used and the reaction involved are $^{6}Li + {}^{2}H \rightarrow 2{}^{4}He$. The masses of the neutral atoms are ^{6}Li 6.01513u, ^{2}H 2.01410u, and ^{4}He 4.00260u. Calculate the expected power production, in MW, associated with the consumption of 1.00 g of LiH perr day. Assume 100% efficiency. [8 marks]

b). A Rankine cycle ocean thermal power plant is supplied with heat from a flow of warm ocean surface water, which is cooled by 15°C as it passes through the boiler. If the plant electrical output is 10 MW and the thermal efficiency is 5%, calculate the volume flow rate of warm water supplied to the boiler. [8 marks]

c). Calculate the power produced per m^2 of wind turbine disk area for a wind velocity of 20 miles per hour, assuming a power coefficient C_p of 0.5 and an air density of 1.2 kg/m^3. Calculate the diameter of a wind turbine that would supply a 1 MW of electrical power under these conditions. (1 mile = 1.609 km) [9 marks]

Question 4

a). Pressurized water reactor (PWR) fuel consists of cylindrical rods put into bundles; a uranium oxide ceramic is formed into pellets and inserted into Zircaloy tubes that are bundled together. In boiling water reactors (BWR), the fuel is similar to PWR fuel except that the bundles are "canned"; that is, there is a thin tube surrounding each bundle. What is the purpose of the difference in the BWR fuel? [8 marks]

b). Nuclear power plants are generally (although not always) considered "hard" targets. In the US, the plants are surrounded by a double row of tall fences which are electronically monitored; the plant grounds are patrolled by a sizeable force of armed guards. How is a terrorist force in a goal to release radioactivity hampered or discouraged by a nuclear reactor design? [8 marks]

c). A proposed hydroelectric power station would produce maximum power when the volume flow rate reached 100 m^3/s at a head of 10 m. (a) If the turboelectric machinery operates with an efficiency of 85%, calculate the maximum electric power output of the facility. (b) If the annual average capacity factor of the plant is 65%, calculate the annual income from the sale of electric power if the selling price is \$0.03/kWh. (c) If the capital cost of the power plant is \$1000/kW, calculate the ratio of annual income to capital cost, expressing the result as %/year. [9 marks]

End of Paper